NO_X Emission Trading in the Northeast:
Trends and Outlook

NETL SCR-SNCR Conference
May 2002
Pittsburgh, PA

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Carnegie Mellon Electricity Industry Center

- Founded in August 2001 with support from the Alfred P. Sloan Foundation and EPRI
- Goal: conduct research and education in partnership with industry that will help:
  - Improve electric service to consumers
  - Increase industry productivity, take advantage of new business opportunities and create wealth
  - Speed organizational learning
  - Enhance human resources
- Co-Directors: Lester Lave, Granger Morgan
- Learn more at www.cmu.edu/electricity

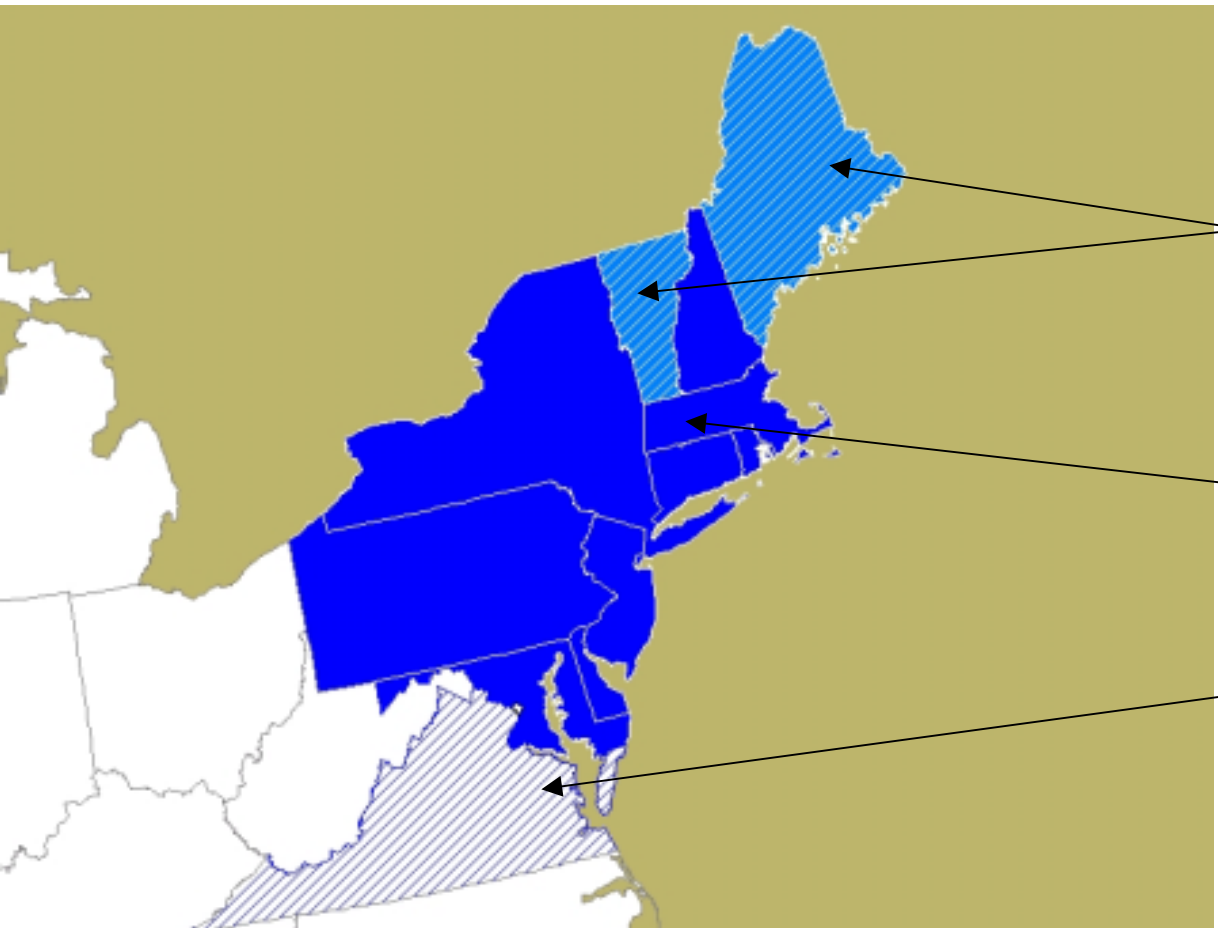
Cap-and-Trade Framework

- Government:
  - Set total mass emissions (cap)
  - Create and allocate emission allowances
  - Require sources to redeem one allowance for each unit of emissions
  - Define emissions monitoring protocols
  - Define any additional rules and enforce (if needed)

- Firms:
  - Control exactly, or
  - Overcontrol (sell or save), or
  - Undercontrol (buy or use savings)

Who's in

- Adopted by nine states in the Ozone Transport Commission (1994-98)
- 970 combustion units participate, mostly power plants



How it works

- Cap:
  - Baseline (1990): 473,000t
  - Phase 1 (1997-98): 320,000t (32% reduction)
  - Phase 2 (1999-2002): 210,000t (0.20 lb./mmBtu, 56% reduction)
  - Phase 3 (2003+): 120,000t (0.15 lb./mmBtu, 75% reduction)

(All values approximate)

- Special Rules
  - Ozone season (May-September)
  - Potential discount on banked allowances – Progressive Flow Control
  - Set-asides for new business, efficiency, or renewables (by state)
  - Maryland does not participate fully in the beginning of Phase II

Emissions and compliance

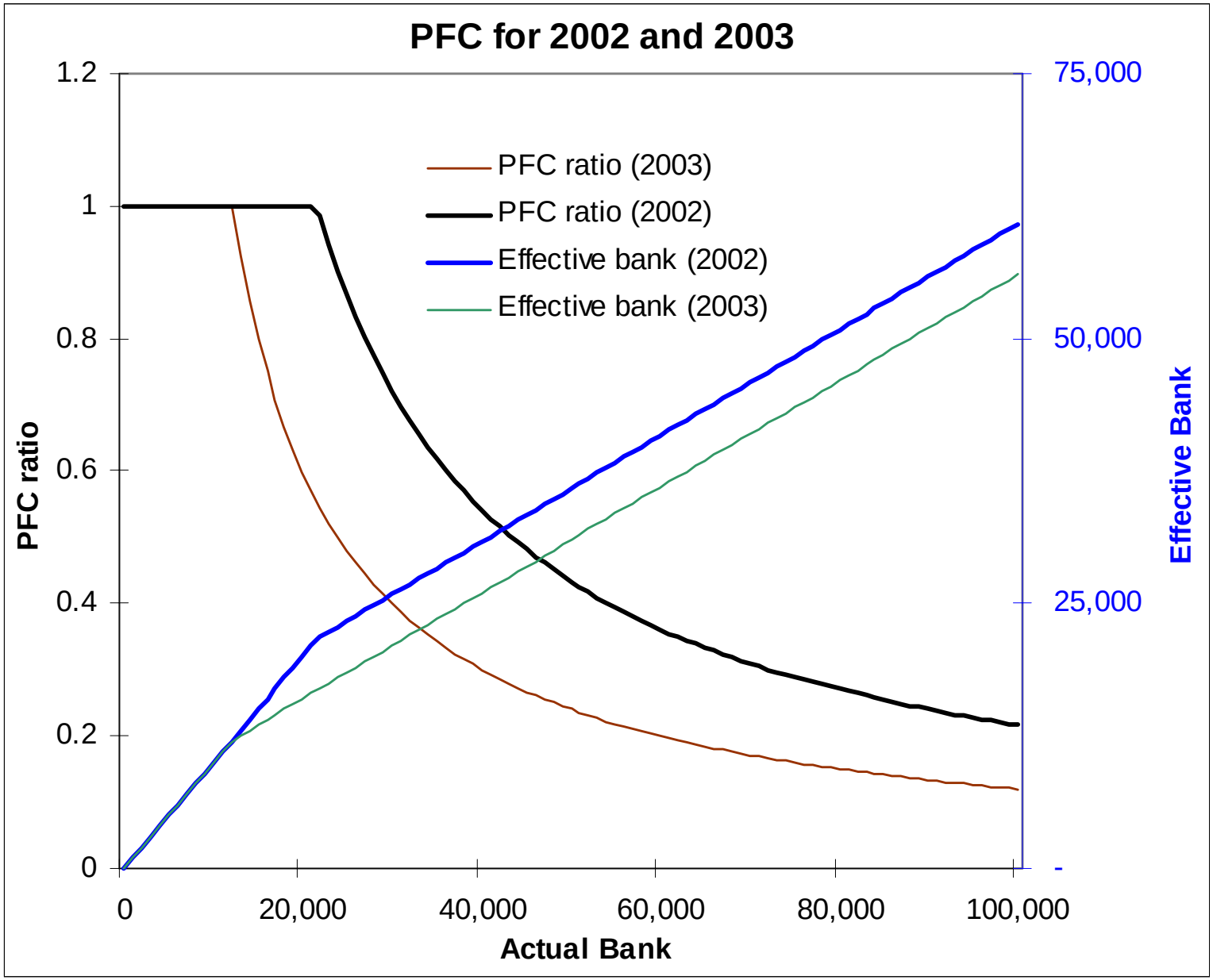
- Allocations and emissions (tons) from all sources:
  - 1990 baseline: 473,011
  - 1999 allocated: 219,438; actual: 174,843
  - 2000 allocated: 195,401; actual: 174,492
  - 2001 allocated: 207,756: actual: 183,283
  - Banked allowances at end of 2001: 78,746
- ~ 61% reduction in NO_X emissions in 2001.
- ~ 1.5 lb. NO_X/MWh in 2001
- Five plants had penalty allowances deducted (57 tons)
- Bank at the end of 2001: 78,746 tons
  - About 66% of a year's worth of Phase 3 allowances
  - Progressive Flow Control (PFC)

Sources: EIA and EPA

PFC - Concept

- Intended to limit the variability of emissions associated with the use of banked allowances.
- Withdrawals from the bank are unlimited, but a discount of 50% is applied to a fraction of allowances in each account.
- The fraction is called the PFC ratio, which is determined by aggregate behavior.
- PFC ratio = (0.10 x seasonal budget) / (total bank)
  - PFC_{02} = (0.10 x 216,551) / (78,746) = .27
- Example: Company X has 200 allowances in the bank. 54 are available for use in 2002 at a 1:1 ratio, 146 are available at a 2:1 ratio, so they can cover 127 tons of emissions (54 + 146/2 = 127).

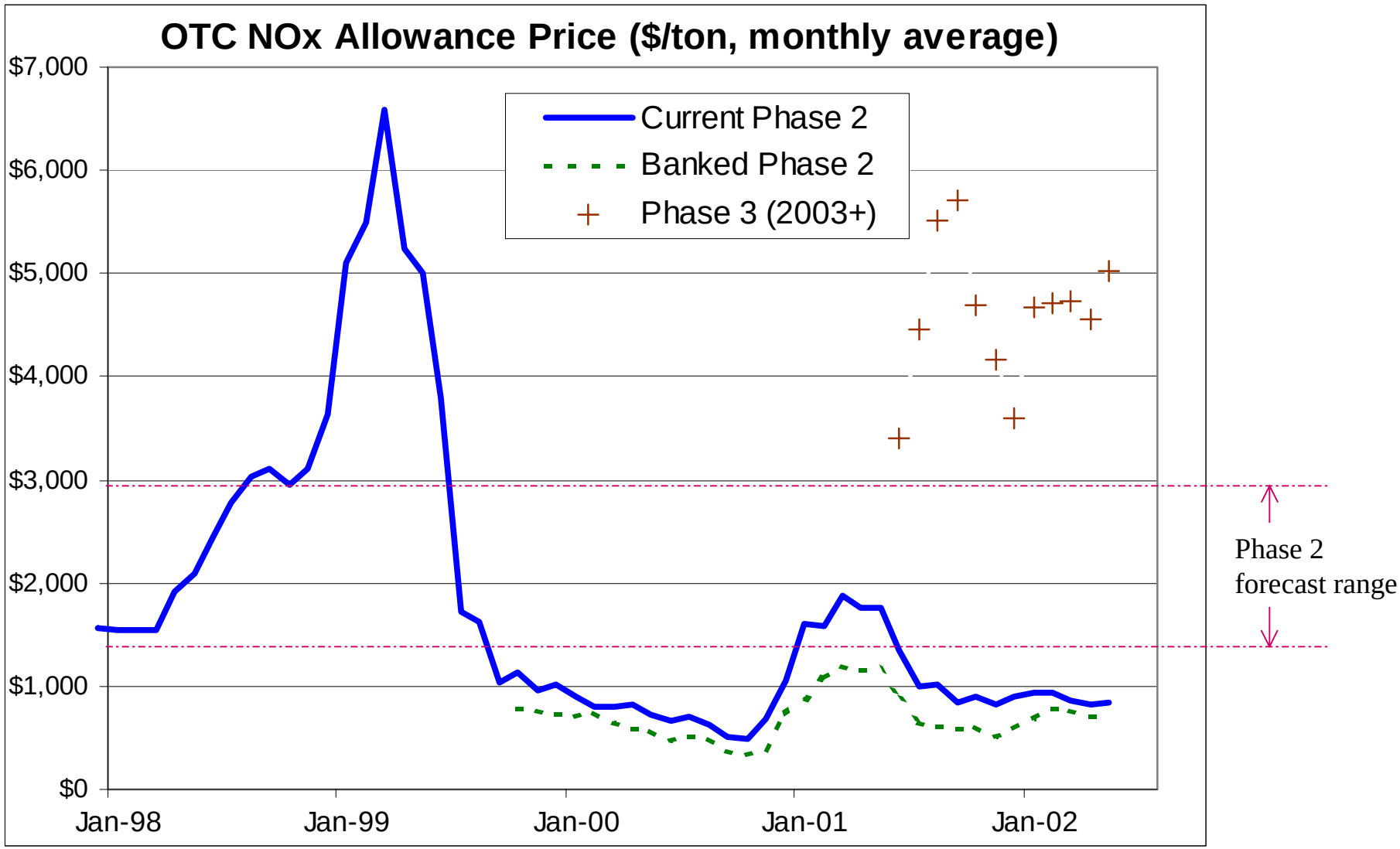
PFC – Graphical



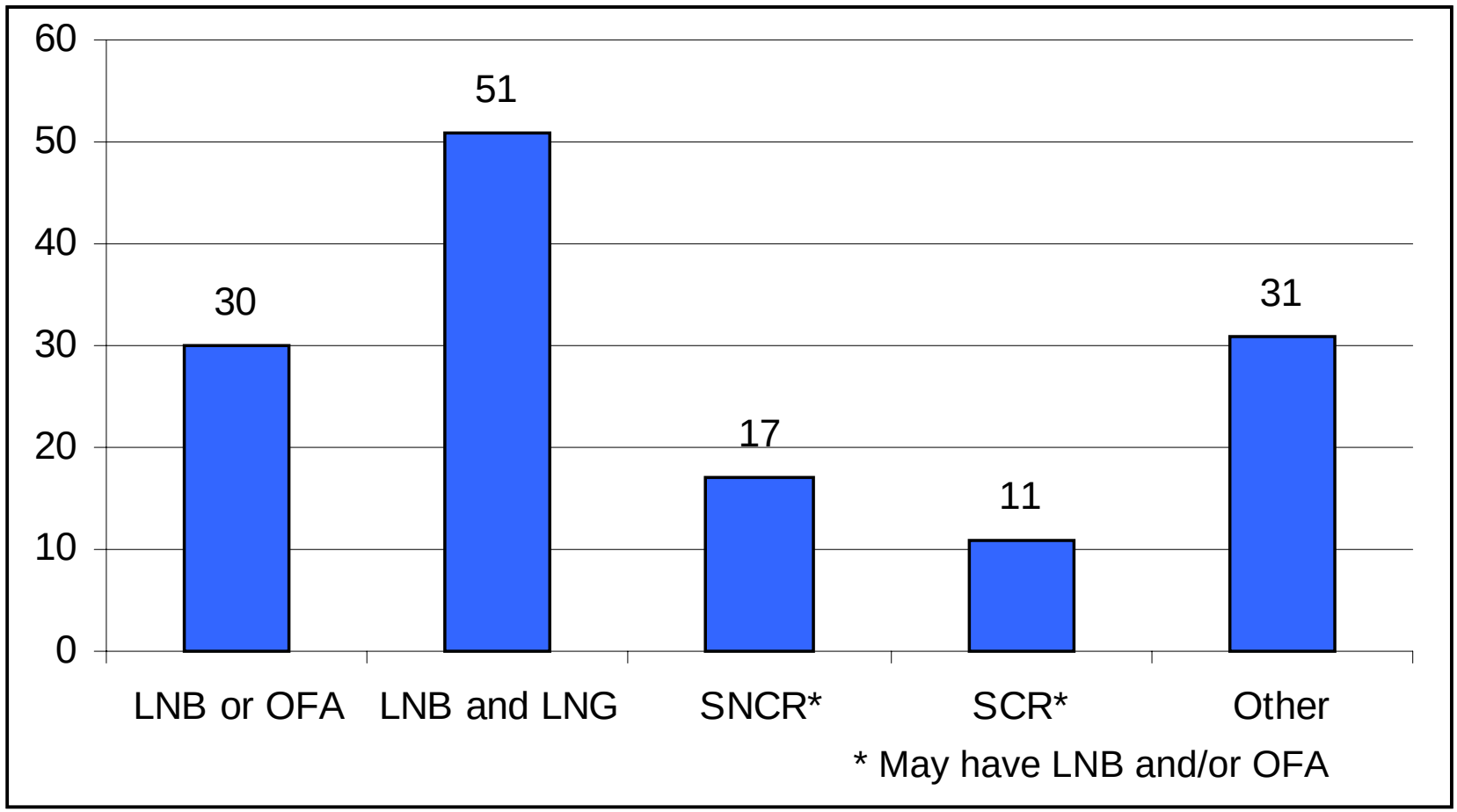
PFC – Implications of Phase 3

- PFC_{03} = (0.10 x 120,000) / (103,219) = .12
- Example: Company X has 200 allowances in the bank. 24 are available for use in 2002 at a 1:1 ratio, 176 are available at a 2:1 ratio, so they can cover 112 tons of emissions.
- Reduction in effective bank is about 4,800 tons of emissions.

OTC NO_X Budget – Allowance Prices



OTC NO_X Budget – Control Technologies
(number of electricity generating units)



Note: Up to 18 SCR units on order in the OTC by January

Source: NETL

Estimates of average performance ($lb.NO_X/mmBtu$)

- EPA (OTC sources, 1999)
  - LNB: 0.41 (Wall)
  - LNB: 0.33 (Tan)
  - LNB + OFA: 0.38 (Wall)
  - LNB + SNCR: 0.32–0.35
  - SCR only: 0.18–0.30

NETL (Nationwide, 2000)

- LNB: 0.44 (Wall)
- LNB: 0.35 (Tan)
- LNB + OFA: 0.42 (Wall)
- LNB + SNCR: 0.48
- SCR only: 0.97
- LNB + SCR: 0.48

Conclusions

- Trends
  - Significant over-compliance and a sizeable bank.
  - Emissions reductions of ~61% with excellent compliance.
  - Except during a start-up period, allowance prices for Phase 2 have averaged about $1,100/ton, but recently about $850/ton.
  - A wide array of technologies, many SCR units now on order

- Outlook
  - One more year of overcompliance, then draw-down of the bank
  - Emissions rate will approach 1.0 lb. NO_X/MWh
  - PFC will become more binding
  - Higher allowance prices for Phase 3: $4,000-$5,000/ton.
  - More technologies and more experience – competition and learning should help contain costs